borax treatment. This method can be used when it is necessary to color the fruit. The average percentage of control was 91 percent.

(b) Partial debuttoning on pulling including removal of the calyx. The average percentage of control was 88 percent.

(c) Partial debuttoning mechanically. The average percentage of control was 86.4 percent.

(d) Partial debuttoning mechanically followed by a borax treatment. The control was practically 100 percent.

3. Blue mold, including loss from other mold fungi, was decreased by some of the above methods and was not increased by the others. Hence the total loss of fruit from all causes was low, less than 5 per cent, for the partial debuttoning plus borax.

4. While there still remain some problems on the practical application of these methods, the large number of oranges used and the manner in which the experiments were arranged give very high degree of certainty that they are effective procedures in controlling stem-end rot and blue mold.

Acknowledgement

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PROGRESS REPORT ON PURPLE MITE AND ITS CONTROL

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The purple mite, **Paratretranychus citri** McG., belongs to a group of mites which are commonly called red spiders. This mite is found in all citrus areas in Florida and has been known to be in the state since before 1885 (Riley (5)). In the Proceedings of the Florida State Horticultural Society for 1905, A. B. Harrington discussed control of the usual red spider infestation. Quayle (6) states that it has been a serious pest in California since 1900, and it has also been of more or less importance in Texas and Alabama. Until recently it has been considered of minor importance in Florida. In 1922 Yothers (8) stated that 95 percent of the total damage caused by insects and mites was attributed to 6 species which did not include the purple mite, and of 10 species named as being of commercial importance, the purple mite was

listed in eighth place. It is rather difficult to determine just when it did become of major importance in this state but reports of infestations have been increasing during the past 6 years with the winter of 1943-44 holding the record, but infestations of a local nature have been common for years. From some of the early descriptions of injury caused by withertip (**Colletotrichum gloeosporioides** Penz), and from our present knowledge of purple mite injury and the ensuing infection of the affected twigs by the withertip fungus it seems safe to assmue that the purple mite was responsible for some of the injury reported as withertip. In 1931 Rhoads and DeBusk (7) described a type of withertip which developed during winter months after the roots had been injured by drought, and the picture of an affected tree shows bare twigs and wilted leaves similar to injury caused by the purple mite. During the winter of 1938-39 heavy purple mite infestations occurred in the Sebring and Lake Placid areas as well as at Port Mayaca, Merritt Island, and to some extent in Orange and Polk counties. During that winter several incidents occurred which indicated that the withertip fungus was secondary and the primary injury was caused by a combination of dry weather and a purple mite infestation. To illustrate, in early November of 1938 dead branches and withertip developed in a number of blocks of orange trees in a rather large grove which was not suffering to any extent from dry weather. It so happened that the Florida red scales were becoming abundant in some blocks, and they were sprayed with an oil emulsion. In late December the dying back of some branches recurred in certain blocks, and upon investigation it was found that where the oil spray had been applied during early December there was no injury and the foliage was free of purple mites, whereas in the blocks where injury had recurred the leaves and especially the twigs were heavily infested with mites. Since then many similar observations have been made by the writer and others who are in close touch with this work. Further information about purple mite injury will be discussed later in this paper.

The reasons for the recent general increase of fall and winter infestations have not been determined; however, there are several factors which may have a general bearing on the problem. The purple mite thrives on young, vigorous foliage, and under the present fertilizer program practiced there is more of that type of foliage during the fall and winter months than there was under the old N-P-K program when many groves were deficient in various other nutrients. Under the old program there was preponderance of more or less chloroitc leaves unsuitable for purple mite development during the fall and winter months, but under the present fertilizer program practiced by a large majority of growers, the summer and fall flushes of growth appear in greater abundance than formerly which furnishes a good supply of food for the mites. The purple mite thrives during periods of cool weather so the cool weather, beginning last October, and the presence of new, vigorous growth which was especially abundant last fall may have been causes affecting the mite population in so many groves during the past winter.

Some growers are of the opinion that nutritional sprays are responsible for the increased number of purple mite infestations. At the present there is no indication that zinc or copper sprays applied during the spring have had any influence on the following fall and winter infestations. In fact, heavy fall infestations were observed in groves that had never received any sprays containing zinc or copper. Some of the severe infestations of 1938-39 were in groves where the practice of applying nutritional sprays had not yet been adopted. To give a specific illustration, at the Citrus Experiment Station there are two experimental fertilized blocks (Blocks 8 and 10) of Pineapple oranges adjacent to each other. Each spring Block 8 receives sprays containing compounds of zinc and copper but in Block 10 those

materials are supplied as a soil application. During the season of 1942-43 there was a crop of fruit on both blocks but the strain of the crop was much more noticeable on the trees in Block 10 than in Block 8 which was in a more vigorous condition. In December of 1942 it was necessary to control a purple mite infestation in Block 8 but mites were very scarce in Block 10 where the trees had a hard appearance. In the spring of 1943 Block 8 set a normal crop of fruit but there was practically no fruit set in Block 10. Due to the lack of crop strain the trees in the latter plot were in a more vigorous condition in the fall of 1943 than during the previous year and by December both blocks had equally heavy infestations. It is realized that one such observation is not conclusive but from observations made in other groves the indications are that the type of growth and climatic conditions have more influence on the occurrence of winter infestations than any spray applied during the spring. There was evidence, however, that the immediate infestation was heavier following a spray containing compounds of zinc or copper than where those materials were omitted. For the past 12 years the writer has used copper compounds in experimental program sprays, and zinc compounds have been used for nine years. In comparing insect and mite populations on sprayed and unsprayed plots it has been found that on an average purple mite infestations were heavier on the sprayed plot than on the checks. Also, where the sprays contained materials toxic to the mites the reinfestation occurred sooner in plots where copper or zinc compounds had been included in the spray program than where those materials were omitted, although the initial control in all plots appeared to be equal. Sulfur sprays have been equally effective in upsetting the natural balance of control. Reinfestations of purple mites as well as rust mites have commonly been more severe following a sulfur spray than adjacent plots where no spray of any kind had been applied within the year. In regard to purple mite infestations following various spray combinations, the data in Table 1 demonstrate the increase which occurred following nutritional-sulfur sprays and sulfur sprays compared to the lack of increase in an unsprayed check plot. The most significant difference was the low per-

TABLE 1. Purple Mite Infestations Following Dormant Sprays.

Materials and Dilutions	% Leaves infested 2 months after spray	
Sprays applied January 31, 1944	Cultivated plots	Non-cultivated plots
Neutral copper 1, Zinc sulfate 3, Lime 1½, Wettable sulfur 10-100	45	37
Lime-sulfur 2 gals., Wettable sulfur 5-100	46	33
Zinc sulfate 3, Lime-sulfur 2 gals., Wettable sulfur 5-100	50	46
Lime-sulfur 2 gals., Wettable sulfur 5-100	49	43
Zinc sulfate 3, Lime-sulfur 2 gals., Wettable sulfur 5-100	58	31
Unsprayed check	5	

centage of leaves infested in the unsprayed check compared to a much higher percentage infested in all of the sprayed plots regardless of the type of spray applied.

It has not been determined just why purple mite infestations develop more rapidly following some of the spray applications except that some of the predaceous mites and insects may be killed by the sulfur contained in most of the sprays for rust mite control. It is also possible that the copper sprays retard the effectiveness of any entomogenous fungi or bacteria which may be present but the work of Holloway et al (4) in California indicates there are other factors involved. He found citrus red mites (same species as purple mites) were more abundant on trees sprayed with a combination of zinc sulfate, copper sulfate, and hydrated lime than on unsprayed trees, and in another test where he used zinc sulfate and soda ash the results were much the same. He states that the possibility of the fungicidal spray inhibiting fungus control was remote as there was no evidence of a fungus being present in the check plots.

It is conceded that almost any spray, whether of a fungicidal or insecticidal nature, upsets a natural control but it must also be admitted that natural control has not been sufficiently effective to accomplish control before too much damage has been done by the offending pest so artificial control has been necessary. It has not been an economic practice to omit one or two essential parts of a spray program in the hope of escaping an infestation of mites because they are likely to appear regardless of the program followed if weather conditions are favorable for their development.

Since the subject of natural control has been mentioned, it might be well to discuss the effect of rainfall in reducing a purple mite infestation. There seems to be a misconception in the minds of many growers as to the extent of control by rainfall. It can be stated for all practical purposes short of a hurricane that the reduction of a purple mite infestation by rainfall is negligible. Population counts have been made before a hard rainfall and within a day or two afterwards, and there was no significant difference in the density of the population. Even if the mites were washed from the leaves those hatching from the eggs on the leaves and fruit would soon reinfest the trees. There is also the theory that several days of rainy weather will create conditions unfavorable for purple mite development, but there evidently are other conditions necessary to cause their disappearance. During 1943 in one grove under observation there was a steady increase of purple mites during May and June, yet between May 17 and May 31 it rained every day except one and during that period there was a total of 9.1 inches of rain. In one plot where sulfur was used to control the mites the average population increased from 15 mites per leaf on May 10 to 60 mites per leaf by June 15. High temperatures are probably more of a factor in causing mites to disappear in summer than rainy weather. During the summer when the weather is hot mites are very scarce in Florida and Alabama (3), and in California (6) they are not known to occur in the San Joaquin, Sacramento, Coachella, and Imperial Valleys where practically no rains fall during the summer.

Although the purple mite is well known, a description, life history, and seasonal history will be discussed briefly. The eggs are bright red, spherical in shape, and have a small vertical stalk at the top from which guy threads are fastened to the leaf. Eggs are deposited on leaves, usually along the mid-rib, on fruit, and on young twigs. The young six-legged larvae are a pale red color but the color soon becomes a dark red. After the first molt they have 8 legs, typical of spiders. In the process of growing there are 3 molts but 2 or 3 days before the last molt the mite is not active and sometimes the mites in this stage are mistaken for dead ones.

During warm weather the eggs probably hatch in from 4 to 6 days but in cool weather the period is extended to 10 days to

2 weeks or longer. There is an approximate period of one to 3 weeks for the young to reach maturity, the length depending on the temperature and time of year. In Florida the most rapid development of mites appears to be in April, May and early June, but during late June and early July the population usually decreases very rapidly, and during August, September and early October mites are so scarce that they are seldom observed. They again appear during November and may be present throughout the winter and spring months.

Migration is no doubt accomplished by the wind carrying the mites. In California various men in research work have observed the adult mite hanging from a short web, one-half to one inch in length, and this web acts as a sail which is carried by the wind. In some of our experimental work where repeated detailed examinations were being made in treated plots a scattering of adult mites would sometimes be observed on leaves that had been practically free of any stage of mites for the past 3 or 4 weeks which indicated that the mites had migrated from nearby groves.

Injury

The injury is manifested on the leaf by a pale color which at first has a stippled appearance, and as the feeding becomes more general the leaf takes on a greenish-gray appearance. If the injury is severe the leaf becomes a dull, lifeless gray color and never regains the deep green luster typical of a normal leaf. Injured twigs have much the same appearance as the leaves; young fruit sometimes becomes quite gray from mite injury but as a rule it seems to color normally in the fall. Following a spring infestation there was some indication that Hamlin oranges were marked while they were small and the injury resembled early rust mite injury.

The writer has not been able to measure the injury caused by mites on the spring flush of growth. It can be assumed that leaves cannot function normally if they are lacking in a certain amount of chlorophyll, but no drop of new leaves has been observed following heavy spring infestations on the young growth. However, the injury caused by infestations during the fall and winter months has resulted in a heavy leaf drop in many groves. The leaf drop is usually associated with dry weather or following a dry wind. As stated previously in this paper, the purple mite prefers young growth so the leaves and twigs of the summer and fall growth have been the most heavily infested during the winter months, and it was that growth which was most affected. Leaves on individual twigs died and dropped, and as a rule if the injury occurred in November or December the twigs also died. Quite often the leaf drop was on the windward side of the tree and occasionally such a leaf drop has occurred in groves that have had no recent mite infestation, but it has been observed that leaf drop was more severe where purple mites were present. Quayle (6) describes the same type of injury in California as being caused by the citrus red mite (purple mite) and dry winds. This particular type of injury is sometimes called mesophyll collapse which, according to the plant physiologists, is caused by the leaf losing water faster than the root system can supply it with the result that the mesophyll cells collapse and the leaf dies. In regard to the part purple mite injury has to do with mesophyll collapse, the twig injury probably is as much, if not more, responsible in causing such a condition than leaf injury. During the cool months mites are often more abundant on the young twigs (wood) than on the leaves and the favorite feeding area is at the axil of the leaf.

For the past 6 years it has been felt by a limited number of people who were in close touch with the work that purple mite injury was at least partly responsible for mesophyll collapse since the condition seldom occurred in groves free of mite injury. Some observations were made where parts of certain groves had been sprayed in the fall with an oil emulsion for scale control and no mesophyll collapse developed, but in the unspray-

ed portion of some of those groves mesophyll collapse did develop along with or following purple mite infestation. During the winter season of 1943-44 the severe leaf drop coupled with the heavy purple mite infestations left little doubt in the minds of most growers that purple mite injury was in part responsible for the heavy leaf drop. The correlation of leaf drop to mite population was demonstrated in some experimental plots this past season. On December 8 an application of DN-Sulfur dust was made with the Master Fan duster on one-half of a grove, and on December 9 the remainder of the grove was dusted with the same kind of dust but the application was made with a single outlet duster of the type commonly used in Florida. Very good control was obtained in the portion of the grove dusted with the Master Fan duster, but due to poor coverage the control was not so satisfactory where the single outlet duster was used. By February 1 that part of the grove dusted with the single outlet duster was again heavily infested and a leaf drop was noticeable and by February 9, or one week later, 82 percent of the trees had a medium to heavy leaf drop. In the portion of the grove where good control was obtained only 5 percent of the leaves were found to be infested and only 15 percent of the trees showed a medium leaf drop. It was interesting to note that the leaf drop could be detected to the row where a heavy infestation existed (Table 2.)

TABLE 2. Leaf Drop Following Reinfestation of Purple Mites on Orange Trees. Dust Applied Dec. 8 and 9, 1943. DN-Sulfur Dust.

Dusting Equipment	% Leaves Infested		% of Trees with Varying Degrees of Leaf Drop					
			February 1			February 9		
	Jan. 11	Feb. 1	Light	Med.	Heavy	Light	Med.	Heavy
Master Fan Duster	1	5	100	0	0	85	15	0
Single Outlet Duster	28	70	42	51	7	18	35	47
Untreated Check	57	90	31	43	26	No Record		

Results of experimental work and observations made by competent field men and growers indicated that purple mite injury is of real consequence. The severity of infestations will no doubt vary from year to year which makes it necessary for grove operators to include purple mites in the list along with other insects and mites when inspections of the groves are made. It is especially important to inspect for mites between September and May, and if only an occasional mite is found in October or early November it is an indication that one will have a potential infestation before spring if weather conditions are favorable. During the winter months if mites are present they are more likely to be found on the south side and the tops of the trees. Also, during that period of the year twigs as well as leaves of the summer and fall flush of growth should be inspected.

Control

In the purple mite work at the Citrus Experiment Station many materials were tested in a preliminary way but only a few of the more promising ones have been tried extensively. Lime-sulfur has been used for years for mite control but in recent years it has not been satisfactory. Sometimes a dormant application of lime-sulfur 2-100 plus wettable sulfur 10-100 seemed to hold the mites in check but when weather conditions were favorable for mite development it was of little value and of the 5 materials tested extensively it was the least effective.

An oil emulsion spray has been as effective and economical as any of the materials tested, especially when it is considered that it also reduced infestations of scales, whiteflies, and to a certain extent rust mites. An oil emulsion spray at a dilution of .75

percent actual oil has given as good initial control as stronger concentrations but the period of control has been somewhat longer where the oil was used at a concentration 1 to 1.25 percent actual oil.

A dormant pregrowth (February or March) oil spray has been effective until the summer oil spray except in a few instances where reinfestations occurred by late May. When reinfestations did occur it was felt that the migration of mites from adjacent groves reinfested the grove because no mites were observed 6 weeks after th oil application and the second infestation increased very rapidly.

Spring oil sprays (March, April and May) have also been effective until the summer oil spray in June or July. In recent years it has not been a common practice to apply an oil spray during the spring period because of the danger of injuring young foliage and fruit. A combination neutral copper-oil emulsion spray, 1 percent actual oil, has resulted in satisfactory purple mite control but that combination has not been generally recommended because of possible spray injury on fruit. During the early twenties (8) bordeaux-oil was recommended for melanose and scale control but too much injury to fruit resulted from that spray so its use was more or less discontinued. The now annual occurrence of purple mite infestations in the spring and the difficulty in controlling scale insects with one spray has again created a demand for such a spray. Since 1939 a limited number of experiments have been conducted in which a spring application of a neutral copper-oil, 1 percent actual oil, was included. Injury on oranges developed in some plots in 2 of the 5 years the combination was used, and only a slight amount of injury on grapefruit developed in one of these years. In each instance where injury developed on oranges the copper-oil application was made when a majority of the fruit was between one-half and one and one-fourth inches in diameter. No injury occurred during the same years where applications were made before the fruit reached one-half inch in size.

In general an oil spray, like any other spray, has its limitations. It is a well-known fact that an oil spray should not be applied when the trees are suffering for moisture or during cold weather. Nevertheless, it has been found in the experimental work that if the trees were in a vigorous condition and they were not suffering for moisture, the ill effects of low temperatures following an oil application were not so pronounced as where the trees were weak. A fall oil spray may also retard the coloring of early fruit. There are two important factors to be considered in that connection: (1) when the weather was warm and continued warm, fruit sprayed before it had colored naturally was difficult to color in the coloring room; (2) if the grove received an oil spray during the summer after June 15 and received another in the fall before the fruit had colored, the coloring process was definitely retarded.

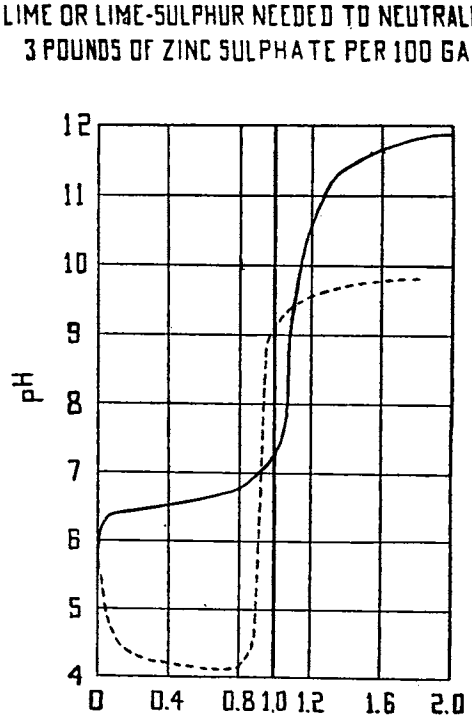
Dinitro-o-cyclohexyl phenol, commonly called DN, has proved a satisfactory material for purple mite control. The DN-Dry Mix (40 percent dinitro-o-cyclohexyl phenol) which is now on the market in Florida has given results equal to an oil emulsion spray except when rainfall occurred within 2 or 3 days after an application. It is used at the rate of 2/3 pound (10 ounces) per 100 gallons of water but it has not caused burn on mature foliage when used at the rate of 3/4 pound per 100 gallons. In practically all tests where various amounts were used, 2/3 pound was as effective as larger amounts. DN was most effective in a slightly acid solution and least effective in an alkaline solution. DN-Dry Mix alone when mixed in water was not so effective because there is not enough wetting agent in it to wet the foliage, but when mixed with wettable sulfur excellent results were obtained. Some other wetting agents besides wettable sulfur proved satisfactory but it was found that DN sprays without sulfur did not result in as long a period of rust mite control

as where sulfur was included in the spray. Wettable sulfur has been used not only for its value for rust mite control but because a mixture of the average wettable sulfur and water is slightly acid.

The average period of purple mite control with DN-wettable sulfur sprays varied with the season of the year and the degree of infestation at the time of application. Sprays applied in late April or early May controlled mites from 6 to 8 weeks or for about the same period obtained with an oil emulsion. Sprays applied in November and early December resulted in control over a period of from 3 to 5 months in experimental plots but in some commercial operations the control is reported to have been satisfactory for as long as 6 months when the spray was applied during the dormant season. As a rule a dormant application of DN-wettable sulfur or an oil spray has been effective until the time for the melanose spray.

DN-Dry Mix is compatible with the neutral coppers, and combinations of neutral copper, DN and wettable sulfur have proved satisfactory. The initial kill from the DN in this combination has been the same as where the DN-wettable sulfur was used but in the spring period the reinfestation has occurred sooner where copper was included in the spray than where it was omitted; nevertheless, on an average the DN in the copper-wettable sulfur spray has controlled the mites until time for the summer oil application. The exceptional failure of the DN in the copper-wettable sulfur spray to control the mites was in heavily infested groves which received the average type of melanose application which was not sufficiently thorough to control a heavy infestation. During April and May there is a higher percentage of eggs on the under surface of the leaves than during the winter months which necessitates a rather thorough coverage if lasting control is to be expected. Light infestations have been controlled where DN was added to the copper-wettable sulfur spray by the usual melanose type of coverage.

Another combination spray in which DN is desirable is the dormant nutritional zinc-sulfur spray, but since DN is not so effective in a highly alkaline spray it has been necessary to use less lime than is ordinarily recommended. The nutritional spray recommended for general use is either zinc sulfate 3 pounds, hydrated lime 1½ pounds, and wettable sulfur 8 to 10 pounds per 100 gallons; or zinc sulfate 3 pounds, lime-sulfur 2 gallons, and wettable sulfur 6 pounds per



Lbs. of H. Lime Per 100 Gals.————
Gals. of Lime-Sulphur Per 100 Gals.------

Figure 1. Titration curves and pH values determined by C. K. Clark, formerly of the Citrus Experiment Station Staff.

100 gallons. A solution containing 3 pounds of zinc sulfate and 1½ pounds of hydrated lime per 100 gallons of water has a pH of appproximately 11.5. Where DN was combined in a spray containing zinc sulfate

and hydrated lime at the ratio of 2 to 1, the intitial kill was reduced and the reinfestation was much more rapid than where the zinc and lime were omitted from the spray mixture. In sprays where the hydrated lime was reduced to one-third as much lime as zinc sulfate, the DN was much more effective and the period of control was extended. The results in Table 3 show the control obtained with zinc sprays containing DN and various amounts of lime. The results in that experiment were typical of control obtained in other experiments of the same nature. The ratio of 3 to 1 of zinc sulfate to hydrated lime has a pH of approximately 7.4. Since a pH of 7.0 is neutral there is a very narrow working margin, especially under field conditions, between a pH of 7.4 and an acid solution, (Figure 1.) A slight error in over-weighing the lime, as little as 0.2 of a pound per 100 gallons, would increase the pH to 10.5 which would affect the toxicity of the DN and an error in under-weighing of 0.2 of a pound would result in an acid solution having a pH of 6.8 which is near the point where the zinc would become soluble and cause injury.

When the trees are dormant there is not much danger of burn from a spray containing zinc sulfate and hydrated lime at the ratio of 3 to 1 but very careful weighing should be practiced if that ratio is used during the melanose spray when young foliage and fruit are present. In any case if the above ratio of 3 to 1 of zinc sulfate to lime is used certain precautions should be observed. Use scales that weigh correctly, weigh all materials carefully, and determine whether the water being used is acid or alkaline. The water from some lakes is very acid and if that type of water is used it may lower the pH enough to cause the zinc to become soluble which would likely injure the fruit and foliage. It is well to follow a certain procedure in mixing spray materials where DN is to be used in zinc-lime spray. The zinc sulfate should be dissolved in the tank then add the lime, then the wettable sulfur and when the tank is at least half full, add the DN. If the DN and lime are added first the toxic effect of the DN will be destroyed. Upon investigation of several complaints that DN was not effecting control, it was found that one operator was adding the DN and lime first and another operator was dumping the materials into the tank just as he happened to come to them.

Manganese sulfate is usually included in the dormant nutritional spray in areas where the pH of the soil is 6.0 or higher (Camp (2)). If DN is to be used in a combination spray containing zinc sulfate and manganese sulfate, a different ratio of the amount of metals to the amount of lime should be used than with zinc sulfate and lime. The amount of lime required to neutralize manganese sulfate is less than that required to neutralize the same amount of zinc sulfate and a ratio of 4 to 1 of equal amounts of zinc sulfate and manganese sulfate to lime is recommended when DN is to be used in such a spray. The addition of a neutral copper, DN, and wettable sulfur does not affect the pH to any extent in the nutritional spray, so a typical east coast dormant nutritional — purple mite-rust mite spray would be something like the following formula: Neutral copper 2, zinc sulfate 3, manganese sulfate 3, hydrated lime 1½, wettable sulfur 10, and DN 2/3 (10 ounces) per 100 gallons.

As stated above, DN in alkaline solutions has not been so effective as when used alone with wettable sulfur but the addition of DN in dormant nutritional sprays where the zinc and lime were used at a ratio of 3 to 1 resulted in periods of control for 4 to 5 months. During this past winter of 1943-44 commercial applications made between late December to February 1 were effective at least until May 1 while on some other groves a reinfestation was occurring by April 1. The thoroughness of application and density of population have been contributing factors in determining the period of control.

Lime-sulfur is ordinarily recommended in the dormant spray to neutralize zinc sulfate and many inquiries have been received as to why lime-sulfur cannot be used instead of hydrated lime if DN is to be used. In the experimental work lime-sulfur has been used to neutralize the zinc sulfate in a spray containing DN, but, as shown in Figure 1, a slight error in under-measuring the lime-sulfur would result in a very acid solution or a rather high alkaline solution if there was an over-measurement. For instance, 0.9 gallon is sufficient to neutralize 3 pounds of zinc sulfate per 100 gallons but if as little as 0.8 gallons were used, the solution would have an approximate pH of 4.2 and if 1 gallon was used the solution would have a pH of 9.0. Furthermore, the toxicity of the lime-sulfur is destroyed by the action of the zinc sulfate if only enough is used to neutralize the zinc so there is no object in using it in combination with DN.

In general DN has been found to be most effective with wettable sulfur, next in effectiveness is a combination neutral copper-wettable sulfur spray and least effective when combined with zinc sulfate, hydrated lime, and wettable sulfur although effective enough to warrant the use of that combination whenever necessary, especially during the dormant period. It has been very effective in controlling six-spotted mites in any of the spray combinations that have been tested. DN has certain advantages over an oil emulsion spray inasmuch as it has not retarded the coloring of fruit and it was applied to trees suffering from drouth without any apparent shock.

DN should not be sprayed on very succulent foliage. Almost without exception sprays containing this material injured foliage that had not reached full size and hardened to the extent that there was some firmness of the leaves. No commercial injury has been observed when DN was included in copper sprays for melanose control but injury did develop on fruit and foliage following a spray applied when the temperature was 92 degrees F. Rainfall occurring within 1 or 3 days after applications materially reduced the period of control. A combination of oil and DN should never be sprayed on citrus trees as it will cause severe burn and leaf drop.

TABLE 3. The Effects of Varying Amounts of Lime on the Toxicity of DN-Dry Mix for Purple Mite Control.

Materials and Dilutions Applied May 8, 1942	Average number living mites per leaf	
	May 15	June 6
DN ¾, Neutral Copper 2, Wettable sulfur 6-100	.03	0.5
DN ¾, Neutral Copper 2, Zinc sulfate 3, Lime 1, Wettable Sulfur, 6-100	.13	0.9
DN ¾, Neutral Copper 2, Zinc sulfate 3, Lime 1.2, Wettable sulfur 6-100	.17	1.5
DN ¾, Neutral Copper 2, Zinc sulfate 3, Lime 1.5, Wettable sulfur 6-100	1.75	12.8

Dinitro-ortho-cresol has been tested in

numerous experiments but the results with that material have never been sufficiently satisfactory to warrant recommending it.

Selocide, a selenium compound, has proved satisfactory when used at 1 to 800 in a combination with lime-sulfur and wettable sulfur. The use of this material has been limited because the manufacturer does not recommend its use in sprays containing zinc or copper compounds. There has also been some question raised as to the advisability of spraying it on trees with mature fruit still on them.

DN Dusts

A limited number of tests have been conducted with DN-sulfur dusts for purple mite control. In California, Boyce et al (1) found that dusts containing 1 percent dinitro-o-cyclohexyl phenol were very effective in controlling the citrus red mite, and results from a limited number of tests conducted by the Florida Citrus Experiment Station indicate that if a sufficiently thorough coverage is obtained, the use of such dust would be practical here. In February 1943, trees 6 or 7 feet high were dusted with several different types of DN dust each material containing 1 percent dinitro-o-cyclohexyl phenol. The trees were dusted on 2 sides and about 1 pound of dust was used per tree. These trees were small enough so that a rather complete coverage was obtaind and the period of control was as long as that obtained with a DN-wettable spray applied the same day in another portion of the grove. Later in the spring some larger trees were dusted but the control was not so satisfactory because of poor coverage obtained with the single outlet duster which is the type commonly used in Florida.

During the past winter experiments were continued with DN-sulfur dusts but the applications were made with the type of duster developed in California for applying DN dusts for mite control. Briefly, the duster is equipped with a large multivane fan or blower capable of discharging between 18,000 and 20,000 cubic feet of air per minute. The dust-laden air passes through a tunnel which extends to 2 narrow fishtail outlets. The outlets in the machine used at the Station were 4½ feet high but on the standard machine used for dusting citrus they are 6 feet high. The outlets are equipped with movable fins about 3 inches wide. These fins move back and forth with the result that the moving air turns the leaves in such a way that a more complete coverage of dust is obtained than is possible with the single or double outlet dusters.

DN-sulfur dusts containing 1 percent dinitro-o-cyclohexyl phenol, supplied during the dormant season with the above described duster, resulted in effective control on medium-sized orange trees for 10 to 12 weeks or until time for the melanose spray in April. The most satisfactory control was obtained while the air was calm and there was dew on the leaves. Approximately 1.5 to 1.7 pounds of dust were used per tree. It is necessary for the dust or spray to come in contact with the purple mite to kill it so a more thorough coverage is necessary than for rust mite control. In order to compare purple mite control with DN-sulfur dust where the 2 types of dusters were used, different portions of the same grove were dusted on December 8 and 9, respectively. At the time the dust was applied there was a medium infestation of mites in the portion of the grove where the records were taken. As shown in Table 1, the intitial control was much better and the period of control longer where the dust was applied with the California-type duster than with the single outlet duster. In all fairness to the application made by the single outlet type of duster, more satisfactory control has been obtained in other experiments as well as in commercial operations than was accomplished in that experiment, but the fact remains that at best satisfactory coverage can hardly be obtained with the single outlet duster unless very careful work is done. In some commercial operations the control with DN-

sulfur dust applied with a single outlet duster was sufficiently satisfactory to warrant its use.

The California type duster could be used in the average budded grove but it is doubtful if it would do satisfactory work in high seedling groves. The tops of medium-sized trees were not covered so completely as was desired but if the duster had been equipped with the 6-foot fishtails a more complete coverage of tree tops could have been accomplished. It is the opinion of the writer that a duster of this type could be used to advantage by large grove operators for applying DN-sulfur dusts and sulfur dusts.

Fall and Early Winter Seasonal Programs

At the present time only suggestions can be made for a complete yearly program for purple mite control but it appears that at least 2 treatments, excluding the summer oil, will be necessary for control throughout the year. Since the injury in the fall and winter is liable to cause leaf drop, treatments in those periods are needed. It is usually necessary at some time during the fall or early winter months to apply sulfur for rust mite control and when such a spray is necessary a DN-wettable sulfur combination can be used. If a dust is desired rather than a spray, a DN-sulfur dust can be used which will check the purple mite infestation if both sides of the trees are dusted and careful work is done. The dust application applies to the whole dormant period. If the spray or dust is to be applied in early September high temperatures should be kept in mind since injury is likely to develop if the temperature is likely to reach 92 degrees or over. An oil spray is also practical and very effective during September and October if the groves are not dry and the fruit is not to be picked before mid-December as the spray may retard coloring.

Dormant Nutritional Spraying

This spray is usually applied between January 10 and up until the spring flush of growth starts. If only an occasional mite is observed in the grove when this spray is applied it would be well to include DN. A satisfactory spray would be zinc sulfate 3 pounds, fresh hydrated lime 1 pound, wettable sulfur 10 pounds, and DN 2-3 pound (10 counces) per 100 gallons of water. If the spring growth starts before the dormant sprays are completed the DN should be omitted from the spray.

Spring or Melanose Sprays

If mites were not controlled late in the dormant period, DN can be added to the neutral copper-wettable sulfur spray or to wettable sulfur if copper is not to be used. A copper-oil emulsion spray can be used but the grower should keep in mind the chance of fruit burn, especially on oranges. The use of DN should be discontinued when the temperature reaches 92 degrees F.

Summer Spray

Occasionally infestations extend into mid-July, especially in groves that have been free of mites during the spring; if such is the case, the summer oil should be applied any time after May 14 on grapefruit and June 1 on oranges unless there is a very late bloom and then June 15 is preferred for oranges because of possibilities of marking the young fruit with the oil spray.

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PHOSPHATE RESPONSE IN A VALENCIA GROVE IN THE EASTERN EVERGLADES

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In the 1941 Proceedings of the Florida State Horticultural Society the authors gave a report (1) on fertilizer studies being conducted on a citrus grove in the eastern Everglades. These fertilizer plots are located in tracts 168 and 169 of Flamingo Groves, about six miles west of the town of Davie. The trees are of the Lou Gim Gong variety planted on ridges about 18 inches high and 30 feet apart with the trees 20 feet apart in the row. The surface soil is a mixture of peat and sand quite variable as to the relative proportions of each. This soil is underlain with a porous marl rock. The distance from the surface to the rock substratum varies considerably but the average is about 24 inches.

The plots were laid out in 1934 when the trees were six years old. Each treatment is replicated three times and the plots consist of four trees each with buffer trees between each two plots. The original rate of fertilizer application was two pounds per tree once each year in the spring. This rate has been gradually increased as the trees became larger until the present rate

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